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Hon. Commissioner of Patents and Trademarks
Washington, DC 20231

OFGS File No. : P/1878-109
Inventor : Atsushi SASAKI
Title : LOUDSPEAKER UNIT ADAPTED TO ENVIRONMENT
Assignee : NEC Corporation

Enclosed herewith please find the following documents in the above-identified application for United States Letters Patent:

14 Pages of Specification including Abstract and Claims
9 Numbered Claims Calculated as 9 Claims for Fee Purposes
4 Sheets of Drawing Containing Figures 1 to 4.
X Declaration and Power of Attorney
X Priority is Claimed under 35 U.S.C. §119:
Convention Date March 21, 1997 for Japan Appln. S.N. 9-68167
X Certified Priority Application
X PTO Form 1449 with 1 reference
X Preliminary Amendment
X Assignment
X Return-Addressed Post Card

OFGS Check No. 74322, which includes the fee of $830.00, calculated as follows:

Basic Filing Fee:	$ 790.00
Additional Filing Fees:	
Total Number of Claims in Excess of 20, times $22:	
Number of Independent Claims in Excess of 3, times $82. . .	
One or More Multiple Dependent Claims: Total $270.	
Total Filing Fees or	790.00
Total Filing Fee Reduced 50% for Small Entity:	
Assignment Recording Fee: $40	40.00
TOTAL Filing Fee and Assignment Recording Fee:	$ 830.00

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March 13, 1998
Date of Signature

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P/1878-109

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of
Atsushi SASAKI
Serial No.:
Filed: Concurrently herewith

New York, New York
Date: March 13, 1998
Group Art Unit:
Examiner:

For: LOUDSPEAKER UNIT ADAPTED TO ENVIRONMENT

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the application as follows:

IN THE SPECIFICATION:

Please amend the specification as follows.

Page 6, line 12, after "drives" delete "the operational amplifier for";

line 13, delete "driving".

REMARKS

This Preliminary Amendment is submitted to correct a typographical error in the specification.

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LOUDSPEAKER UNIT ADAPTED TO ENVIRONMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a loudspeaker unit for improving the regenerative tone quality, more particularly to a loudspeaker unit particularly adapted to environment.

2. Description of the Related Art:

A loudspeaker unit of this type has, as disclosed in J.P.A. Gazette 130608/1989, had a reference signal source for comparative correction to be made in correcting frequency characteristics.

Fig. 1 is a structural view showing an example of a conventional loudspeaker unit of a regenerative sound feed back type having a reference signal source to be used for comparative correction. For amplifying sound source 101 with a desired frequency characteristic, switch 103 of the loudspeaker unit is switched to a fixed contact B side, and a level of a sound signal emitted from reference signal source 102 picked up by microphone 107 at a listening point is analyzed to perform a particular procedure for previously setting a gain of each element of graphic equalizer 104.

However, the loudspeaker unit with a corrected frequency characteristic has a problem such that its

frequency characteristic must be corrected by the reference signal every time the installation environment of the loudspeaker unit changes.

Further, with the loudspeaker unit of which only the correction of the frequency characteristic is executed, there is a problem that no correction can be made to a sound lag and a phase shift to be caused by the reverberation and an echo of a sound.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a loudspeaker unit adapted to the environment and requires no particular procedure for correction of the acoustic characteristic thereof even if the installation environment of the loudspeaker unit changes.

Another object of the present invention is to provide a loudspeaker unit which can correct, in addition to the frequency characteristic of the sound, a sound lag and a phase shift ascribable to the reverberation and the echo of the sound.

The loudspeaker unit of the present invention adapted to the environment comprises a microphone for picking up a sound regenerated from a loudspeaker; processing means for comparing at real time an output signal from the microphone with an output signal from a

sound source with reference to the characteristic at an optional frequency and the characteristic of the reverberation as well as the echo each including the delay time, respectively, and correcting a signal from a sound source with the difference output signal between the microphone and the sound source; an amplifier for amplifying the output of the processing means; and a loudspeaker unit.

Also in the present invention, it is allowable to correct a signal to be sent to the loudspeaker by the result learned through arithmetic. It is acceptable to intermittently renew the parameter to correct the signal to be sent to the loudspeaker by using the result of the comparison.

In the present invention, since the sound characteristic is corrected depending on the regenerative sound source, the correction of the frequency characteristic of the regenerative sound based on the reference signal can advantageously be omitted even if the installation environment of the loudspeaker unit changes.

Further, since the sound picked up by the microphone is compared with the sound from the sound source with reference to the frequency characteristic, the reverberation and the echo characteristic, the invention can effectively correct the reverberation of

the sound, the echo delay and the phase shift.

In other words, according to the present invention, the loudspeaker unit can save a reference signal generator to be used for comparison and a switch for selecting this signal.

Further, since the processing module of the loudspeaker unit catches a feedback signal at real time, the particular procedure is not needed for the correction.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a structural view showing an example of a conventional loudspeaker unit of a regenerative sound feed back type having a reference signal source for use for comparative correction.

Fig. 2 is a structural view showing an embodiment of a loudspeaker unit adapted to the environment of the present invention.

Fig. 3 is a structural view showing a concrete embodiment of a loudspeaker unit adapted to the environment of the present invention.

Fig. 4 is a structural view showing another embodiment of a loudspeaker unit adapted to the environment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Next, an embodiment of the present invention will

be described in detail with reference to the drawings.

With reference to Fig. 2, there is provided loudspeaker unit 1 adapted to the environment comprising microphone 6 for picking up a sound issued from the loudspeaker 5, processor module 3 for receiving feedback signal 9 and sound source signal 7, and amplifier 4 for producing the sound from loudspeaker 5.

Next, the motion of Fig. 2 will be described with reference to the drawing.

Sound source signal 7 of sound source 2 to be desirably regenerated is inputted to processor module 3 before it is inputted to amplifier 4. Processor module 3 compares feedback signal 9 inputted from microphone 6 with sound source signal 7. Processor module 3 operates correction data so that feedback signal 9 may come most close to sound source signal 7 for the sake of obtaining a reasonable sound intensity characteristic or the desirable effect of echo suppression, and by applying thus obtained result to inputted sound source signal 7, produces correction signal 8 to send to amplifier 4. Amplifier 4 amplifies correction signal 8 to produce the sound from loudspeaker 5. Since this sound has been corrected at real time with reference to the frequency characteristic or the reverberation characteristic

affected by the property of the installation place of the loudspeaker unit, correction signal 8 approaches sound source signal 7.

Next, a concrete embodiment of the present invention will be described in detail referring to the drawings. With reference to Fig. 3, sound source 2 is a sounder such as a radio tuner, a compact disk or a sound chip of a personal computer. Processor module 3 comprises 16 bit A/D converter 31, 16 bit A/D converter 32, digital signal processor 35, 16 bit D/A converter 33, and memory 34. Amplifier 4 is an operational amplifier. It drives the operational amplifier for driving loudspeaker 5 of 57 mm in diameter with impedance of 8 Ω. Microphone 6 is composed of an electret condenser microphone of 9.5 mm in diameter with a flat frequency characteristic and a microphone amplifier. A cable which transmits feedback signal 9 outputted from microphone 6 is selected from a group of the noise-resistant shielding wire.

Next, the motion of the embodiment of the present invention will be described in detail with reference to Fig. 3.

Signal 7 from sound source 2 is converted to a digital signal by A/D converter 31 of processor module 3 and stored in memory 34. The data of all signals A/D converted within a fixed time stipulated for the

reverberation and the echo are stored as the data of sound source 2 in memory 34. On the other hand, a signal processed as a regenerative signal by digital signal processor 35 of processor module 3 is further converted to an analog signal by means of D/A converter 33, and after amplified by amplifier 4, it is sent forth from loudspeaker 5 as a sound. Microphone 6 picks up this sound, then the sound is converted as feedback signal 9 to a digital signal by A/D converter 32 and inputted to digital signal processor 35. Successive comparison·analysis part 37 of digital signal processor 35 compares the data of sound source 2 stored in memory 34 with the digital data from successive A/D converter 32, analyzes the intensity of the reverberation and the echo, corrects the conversion data stored in memory 34 and gets a correction parameter. Regenerative signal processing part 36 adds the correction parameter to the conversion data of sound source 2 and processes the digital data to regenerate as a regenerative signal. The difference between the data of sound source 2 and the data of feedback signal 9 is obtained as the correction parameter in serial data and the parameter is processed by adding feedback signal 9 of an opposite phase, if necessary, to obtain a fixed number or 0. The processed signal is converted to an analog signal by

D/A converter 33, amplified by amplifier 4 and then sent forth from loudspeaker 5 as the sound.

The intensity of the reverberation and the change of the frequency characteristic are corrected according to the result learned about the data of sound source 2. After clearly grasping the frequency characteristic and the delay of the reverberation as well as the echo, the value set for correction is changed to determine the correction parameter.

Next, a second embodiment of the present invention will be described referring to the drawings.

With reference to Fig. 4, in order to decrease the load of processor module 3, data processing for the correction purpose is not to be performed at real time, but a correction parameter previously extracted from the past example is better used intermittently, and thus it becomes possible to correct the sound delay and the phase shift which may be caused by the reverberation and the echo.

Further, by attaching microphone 6 to a casing of loudspeaker unit 1 of the present invention, the wiring to be laid outwardly from the casing can be omitted.

WHAT IS CLAIMED IS:

1. A loudspeaker unit adapted to environment, comprising:

a microphone for picking up a sound regenerated from a loudspeaker;

processing means for comparing at real time an output signal from said microphone with an output signal from a sound source with reference to the characteristic at an optional frequency and the characteristic of the echo or the characteristic of the reverberation each including the delay time, respectively, and correcting a signal from said sound source with the difference output signal between the microphone and the sound source;

an amplifier for amplifying the output of said processing means; and

a loudspeaker.

2. A loudspeaker unit adapted to the environment according to Claim 1 wherein said processing means for correcting the signal from said sound source comprising:

a first A/D converter for performing digital conversion of a sound signal outputted from the sound source;

a memory for storing the converted voice data of

samples taken within a fixed time determined as a subject time for the delay of the reverberation and the echo;

a second A/D converter for performing digital conversion of the feedback signal outputted from said microphone as the feedback data;

a successive comparison·analysis part for successively comparing said feedback data with the stored voice data, analyzing the intensity of the reverberation and the echo and outputting the result as a correction parameter;

a regenerative signal processing part for adding data corrected by said correction parameter to the stored voice data and processing the result as the regenerative data; and

a D/A converter for converting said regenerative data to an analog signal.

3. A loudspeaker unit adapted to the environment according to Claim 2 wherein said successive comparison·analysis part performs processing by adding antiphase feedback data to said voice data so that the difference between said voice data obtained as the serial data and said feedback data becomes a fixed value or 0.

4. A loudspeaker unit adapted to the environment according to Claim 1 wherein,

the comparison of the characteristic at said optional frequency and the comparison of the characteristic of the echo or the reverberation each including the delay time are learned by arithmetic and a signal to be sent to the loudspeaker is corrected according to the learned result.

5. A loudspeaker unit adapted to the environment according to Claim 2 wherein,

the comparison of the characteristic at said optional frequency and the comparison of the characteristic of the echo or the reverberation each including the delay time are learned by arithmetic and a signal to be sent to the loudspeaker is corrected according to the learned result.

6. A loudspeaker unit adapted to the environment according to Claim 1 wherein,

the comparison of the characteristic at said optional frequency and the comparison of the characteristic of the echo or the reverberation each including the delay time are intermittently performed and a signal to be sent to the loudspeaker is corrected according to the comparison result.

7. A loudspeaker unit adapted to the environment according to Claim 2 wherein,

the comparison of the characteristic at said optional frequency and the comparison of the characteristic of the echo or the reverberation each including the delay time are intermittently performed and a signal to be sent to the loudspeaker is corrected according to the comparison result.

8. A loudspeaker unit adapted to the environment according to Claim 4 wherein,

the comparison of the characteristic at said optional frequency and the comparison of the characteristic of the echo or the reverberation each including the delay time are intermittently performed and a signal to be sent to the loudspeaker is corrected according to the comparison result.

9. A loudspeaker unit adapted to the environment according to Claim 5 wherein,

the comparison of the characteristic at said optional frequency and the comparison of the characteristic of the echo or the reverberation each including the delay time are intermittently performed and a signal to be sent to the loudspeaker is corrected

according to the comparison result.

ABSTRACT OF THE DISCLOSURE

The present invention provides a loudspeaker unit which requires no particular procedure for correction of the acoustic characteristic even if the installation environment of the loudspeaker unit changes, and which can correct, in addition to the frequency characteristic, a sound lag and a phase shift ascribable to the reverberation and an echo of a sound. The loudspeaker unit picks up a sound regenerating from the loudspeaker with a microphone, and compares at real time a sound from a sound source with a regenerative sound, referring to a difference therebetween, with reference to the characteristic at an optional frequency and the characteristic of the reverberation or the echo each including the delay time, respectively, and corrects the signal to be sent to the loudspeaker by the result of arithmetic. Further, correction of signals can be learned through arithmetic, and also correction of signals can be made by utilizing intermittent arithmetic.

Fig. 1 Prior Art

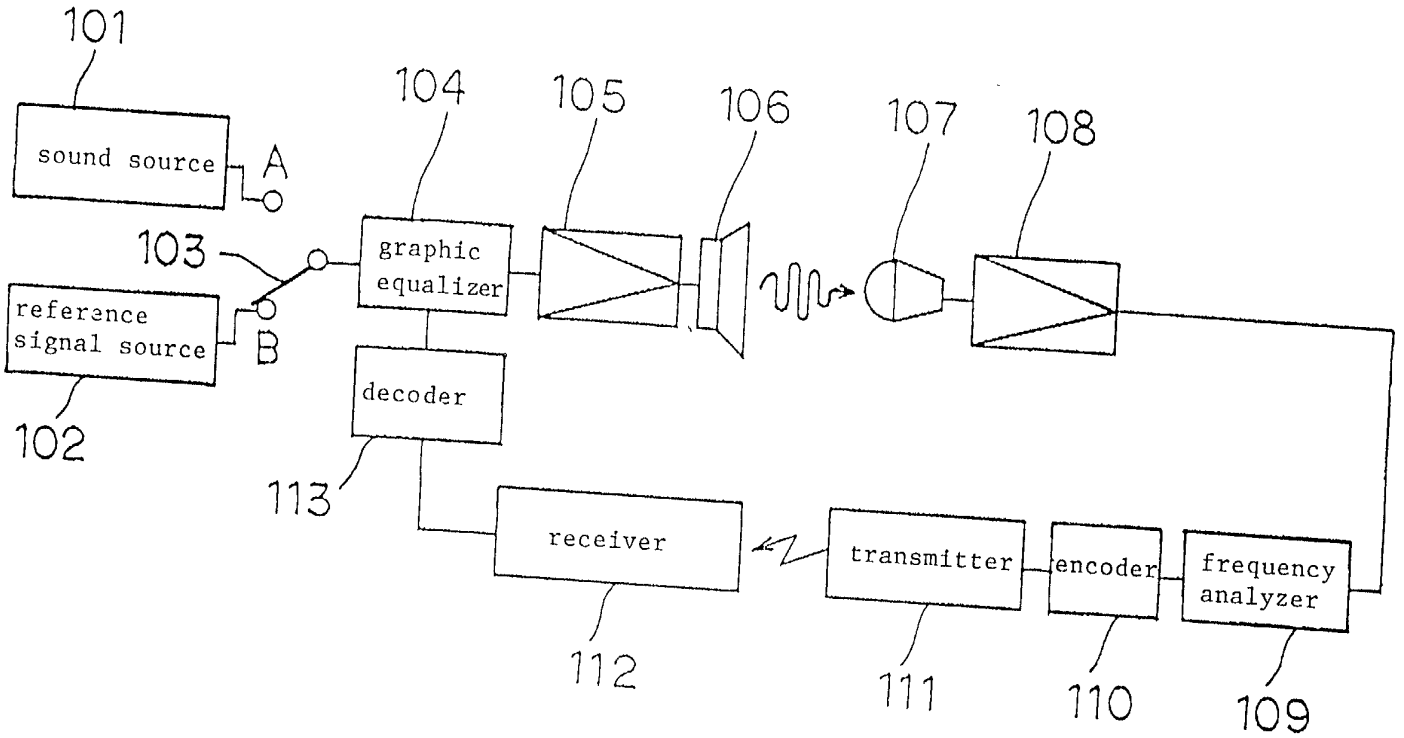


Fig. 2

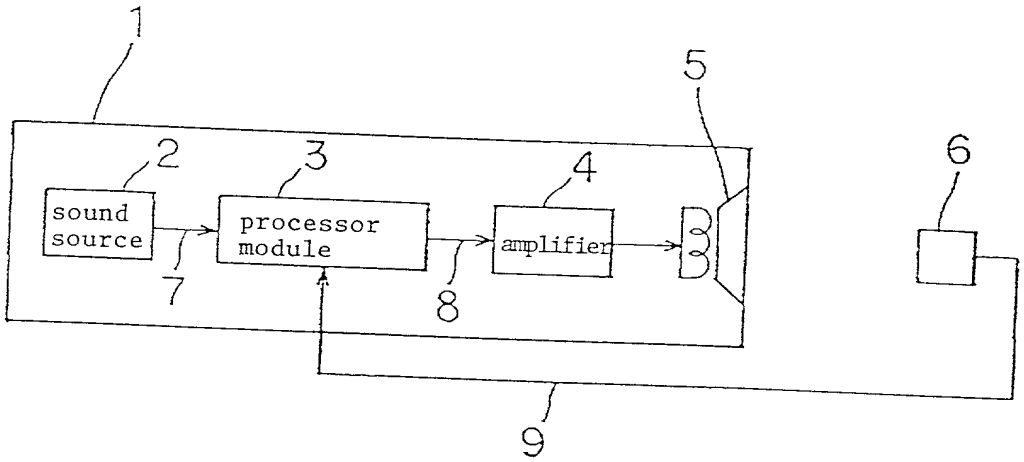


Fig. 3

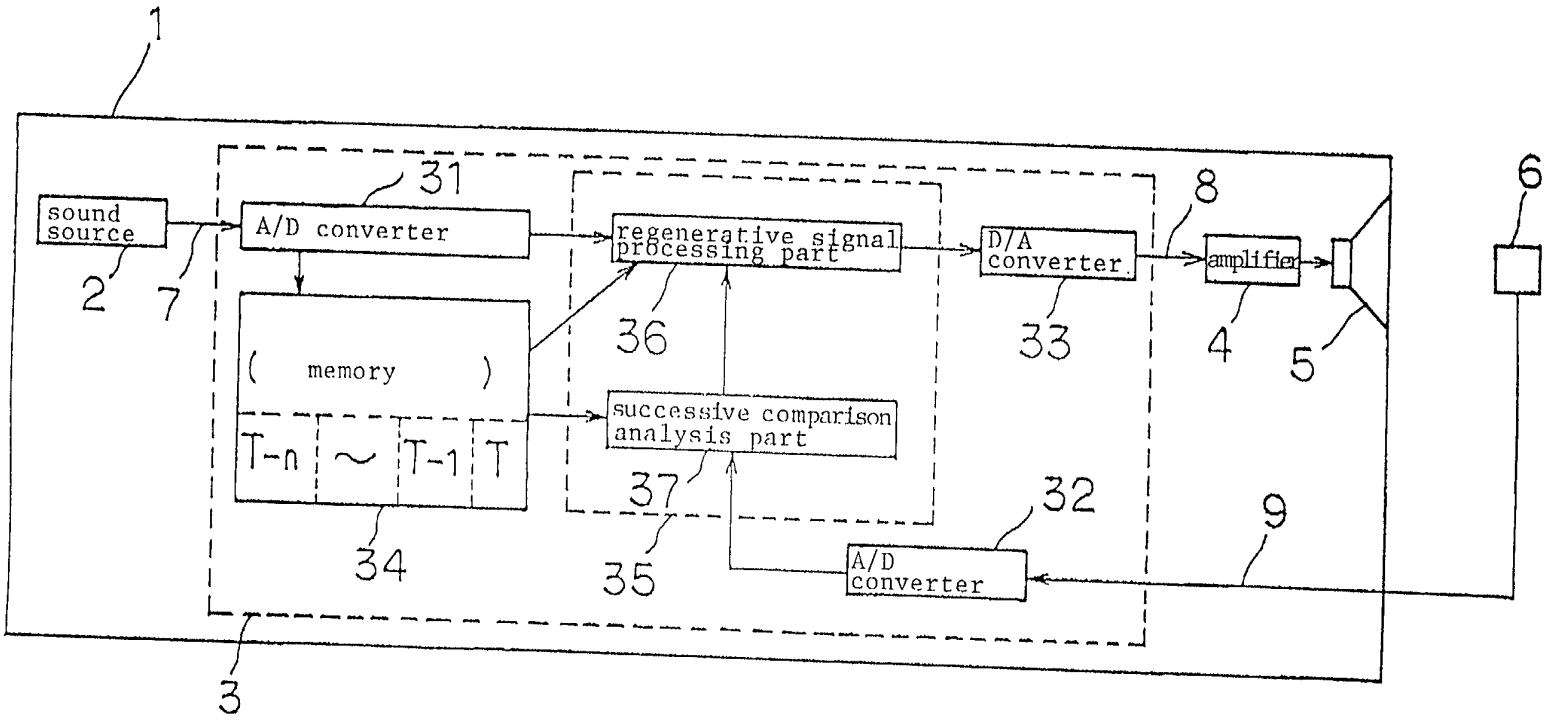
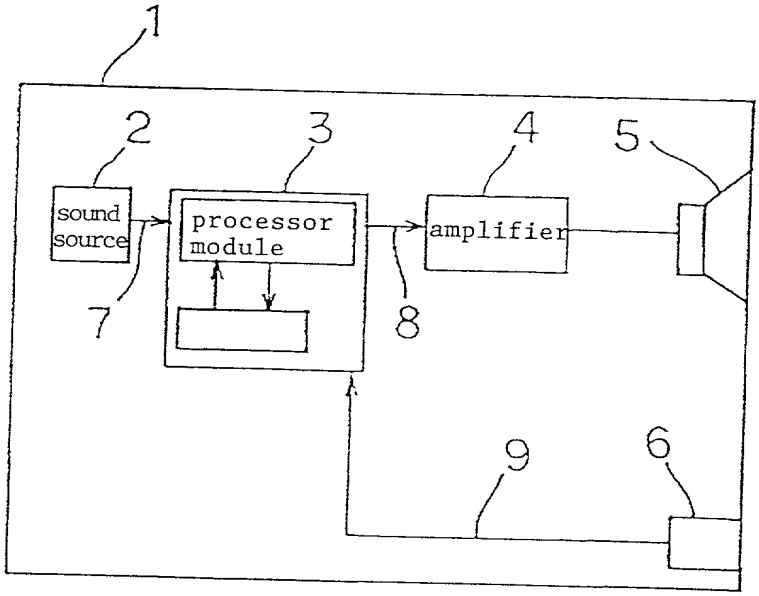


Fig. 4



UNITED STATES OF AMERICA COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION	OFGS FILE NO. P/1878-109

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

LOUDSPEAKER UNIT ADAPTED TO ENVIRONMENT

the specification of which is attached hereto, unless the following box is checked:

☐ was filed on _____ as United States patent Application Number or PCT International patent Number _____ and was amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	PRIORITY CLAIMED UNDER 35 U.S.C. 119
Japan	068167/1997	21/03/1997	YES X NO ____
			YES ____ NO ____
			YES ____ NO ____

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	STATUS (patented, pending, abandoned)

I hereby appoint OSTROLENK, FABER, GERB & SOFFEN, and the members of the firm, Marvin C. Soffen - Reg. No. 17,542; Samuel H. Weiner - Reg. No. 18,510; Jerome M. Berliner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Stanley H. Lieberstein - Reg. No. 22,400; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,173; William O. Gray, III - Reg. No. 30,944 and Louis C. Dujmich - Reg. No. 30,625, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE OR FIRST INVENTOR	INVENTOR'S SIGNATURE	DATE
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RESIDENCE: Tokyo, Japan		COUNTRY OF CITIZENSHIP: Japan
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RESIDENCE		COUNTRY OF CITIZENSHIP
POST OFFICE ADDRESS		
FULL NAME OF THIRD JOINT INVENTOR (IF ANY)	INVENTOR'S SIGNATURE	DATE
RESIDENCE		COUNTRY OF CITIZENSHIP
POST OFFICE ADDRESS		

☐ CONTINUED ON PAGE 2